N94-24432

1993

NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM

MARSHALL SPACE FLIGHT CENTER
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

SPATIAL INTERPRETATION OF NASA'S MARSHALL SPACE FLIGHT CENTER PAYLOAD OPERATIONS CONTROL CENTER USING VIRTUAL REALITY TECHNOLOGY

Prepared By:	Patricia F. Lindsey
Academic Rank:	Lecturer
Institution and School:	East Carolina University, School of Human Environmental Sciences
MSFC Colleague:	Joseph P. Hale
NASA/MSFC:	
Office:	Missions Operations Laboratory
Division:	Operations Engineering Division
Branch:	Crew Systems Engineering Branch

SPATIAL INTERPRETATION OF NASA'S MARSHALL SPACE FLIGHT CENTER PAYLOAD OPERATIONS CONTROL CENTER USING VIRTUAL REALITY TECHNOLOGY

Introduction

In its search for higher level computer interface and more realistic electronic simulation for measurement and spatial analysis in human factors design, NASA at Marshall Space Flight Center is evaluating the functionality of virtual reality (VR) technology. Virtual reality simulation generates is a three dimensional environment in which the participant appears to be enveloped (Nugent, 1991). It is a type of interactive simulation in which humans are not only involved , but included (Helsel and Roth, 1991).

The military and entertainment industries along with the physical sciences have driven the development of computer equipment, programming, and presentation techniques used in the production and presentation of VR generated environments. The development of headsets, high resolution displays and position sensors have enabled the creation of the illusion of existing within a yet unconstructed space (Editorial, 1991).

The general purpose nature of VR technology makes it an intelligence amplifying (IA) tool--utilizing both the computer advantage in calculation and the human advantage in evaluation and putting ideas into context. These advantages are augmented with the use of input gloves, body suits, and display head gear that permits the user to utilize natural movement, rather than typed instruction or symbols and text picked from a menu (Rheingold, 1991).

Virtual reality technology is still in the experimental phase but it appears to be the next logical step after computer aided three-dimensional animation in transferring the viewer from a passive to an active role in experiencing and evaluating an environment (Eschelman and Tatchell, 1991). There is great potential for using this new technology when designing environments for more successful interaction, both with the environment and with another participant in a remote location. At the University of North Carolina, a VR simulation of a the planned Sitterson Hall, revealed a flaw in the building's design that had not been observed during examination of the more traditional building plan simulation methods on paper and on computer aided design (CAD) work station (Aukstankalnis, 1991). The virtual environment enables multiple participants in remote locations to come together and interact with one another and with the environment. Each participant is capable of seeing himself and the other participants and of interacting with them within the simulated environment.

Utilization

Three areas of utilization of VR technology in human factors design covered in this study are: (a) simulation techniques, (b) behavioral settings, and (c) human/computer interaction. Simulations provide a method of presentation of the environment without necessitating on-site visits, permit response to environments to manipulate the prospective environment. Simulation is most useful in situations where observations or experimentation are not feasible or ethical.

Behavioral settings are social and psychological situations in which human behavior occurs (Wicker, 1979). They are both structural and dynamic (Barker, 1968) and include time and place boundaries, duration of setting, number of times setting occurred over a period of time, number of participants, positions of responsibility, demographic group to which participants belong, behavior patterns of participants, and behaviors that occur in the setting (Wicker,1979). In order to understand the behavior of individuals or groups, we must examine the opportunities and constraints encompassed in their environments.

Virtual reality enhances human/computer interaction. Interactive computer programs, using VR simulation take advantage of both the computer advantage in calculation and the human advantage in evaluation and putting ideas into context. Virtual reality weakens the barrier between man and machine by permitting the user to use natural movement rather than symbol or word commands.

Using VR for evaluation of behavioral settings enables exploration of connections between specific environmental attributes and users perceptions of those attributes. Components within a behavioral settings control the range of human behavior by promoting some actions and prohibiting others, therefore observation and research should clarify and supplement that which is known about relationships between physical environments and human behavior.

The Study

Virtual reality simulation is promising but there are no studies to verify that reaction to the VR environment approximates reaction to the "real world" environments. This study compares responses of participants who viewed NASA's Payload Operations Control Center (POCC) at Marshall Space Flight Center with responses of the same participants who viewed the same environment via VR simulation. This study investigates: (a) the potential for using VR to evaluate human/environmental interaction, (b) whether observation of environments using VR simulation provides the same information about the characteristics of that environment as is provided by observation of the "real world" environment, (c) the reliability of using virtual reality to interpret the attributes, deficiencies, and characteristics of an existing or planned environment.

The study is a pretest-posttest design. The sample consisted of 24 volunteers--12 NASA employees who have worked in POCC console positions and 12 university and community college faculty members who have never worked in the POCC. Six from each group were male and six were female. Responses of participants were recorded on a forced response questionnaire, and a semantic differential questionnaire. In addition, six members of the sample were asked to give verbal responses to a moderately scheduled, open ended follow up questionnaire. Responses were recorded on audio tape. The qualitative information gathered from the semantic differential and the follow up questionnaire will be used to clarify the quantitative information gathered from the forced response questionnaire.

Participants were seated at two specified points in both the "real world" and VR POCCs. Questionnaires were completed from these two locations. The participants' seat height was adjusted so that their eye height approximated the eye height of a 50th percentile male at one location and a 50th percentile female at the other location (NASA, 1989). After one set of questions was completed in the virtual POCC, changes were made to the virtual environment and the questionnaire was completed again. Responses before and after the changes will be compared. Questions concerned distance judgment, head rotation, and perception. The sequence of observation was the same from both consoles and in the "real world" and the VR POCCs. The semantic differential questionnaire was completed from the center back of the POCC from a standing position.

The equipment, hardware and software used to create the virtual POCC environment included eye-phones and data glove by VPL research, Inc. A Macintosh 2FX computer, 2 silicon graphics computers--310 VGX and 320 VGX-B. The graphics package is Swivel 3-D by VPL Research, Inc. Body Electric Visual Programming Language connects input by the operator to drive the simulator is translated by Isaac.

Since participants using VR equipment were unable to read the questionnaire or designate the answers while wearing VR gear, the questions and answer options must be read to the participant and answers marked by a surrogate. The researcher or research assistant acted as surrogate. In order that conditions be as alike as possible in both settings, questions were also read and answers marked by the surrogate in the "real world" POCC.

Data from the questionnaires will be coded, entered into the computer and verified for accuracy. Using SPSS, descriptive statistics will be generated including frequencies, means, and percentages. Analytical statistics for all hypotheses will include a repeated measures multivariate analysis of variance to test differences between groups.

Conclusion

Analysis of data has not yet begun but some anticipated conclusions drawn from the data and from comments of participants include a similarity in spatial analysis among groups. Some differences are apparent between participants who have worked at the POCC consoles and those who have not. It appears that there is some difference in responses between those who view the "real world" POCC first and those who view the VR POCC first. Estimation of distances in the VR POCC appear to be similar to estimation of distances in the "real world" POCC up to a distance of about 10 feet. Beyond that, however, the estimated distances in the VR POCC are greater than those in the "real world" POCC. Overall, the estimates of distance, head rotation, perception appear to be similar in both "worlds".

Acknowledgments

Much appreciation is due to the staff in MSFC's Summer Faculty Fellowship Office for advice and support while this study was in progress. Many thanks go to the members of my dissertation committee at Virginia Polytechnic Institute and State University (Virginia Tech), especially to Joan McLain-Kark, committee chair. The committee was instrumental in aiding preparation of this study. Joe Hale and his staff members, Michael Flora, Gina Klinzak, and Peter Wang, along with Patrick Meyer, a participant in the PIP program, have all my gratitude for their generosity of time, knowledge, guidance, and friendship.

References

1. Aukstankalnis, G. Virtual reality and experiential prototypes of CAD models. DesignNet. (1992, January).
2, Barker, R.G. Ecological psychology. Stanford, CA.: Stanford University Press.
3. Editorial Being and believing-ethics in virtual reality. Lancet, 338(8762), 283-284. (1991).
4. Eshelman, P. & Tatchell, K. How beneficial a tool is computer-aided design? Forum. pp. 15-19. (1992).
5. Helsel, S.K. & Roth, J.P. (eds.). Virtual reality: Theory, practice, and promise. Westport, CN: Meckler Publishing. (1991).
6. National Aeronautics and Space Administration (NASA). Man-Systems Integration Standards: SA-STD-3000. National Aeronautics and Space Administration. pp. 3-11 - 3-25. (1989).
7. Nugent, W.R. Virtual reality: Advanced imagery special effects let you roam in cyberspace. Journal of the American Society for Information Science,42(8), 609-617. (1991).
8. Rheingold, H. Virtual reality. New York: Simon & Schuster. (1991).
9. Wicker, A.W. An introduction to ecological psychology. Belmont, CA: Wadsworth, Inc. (1979).